Lecture 2

Analog-to-Digital Converters

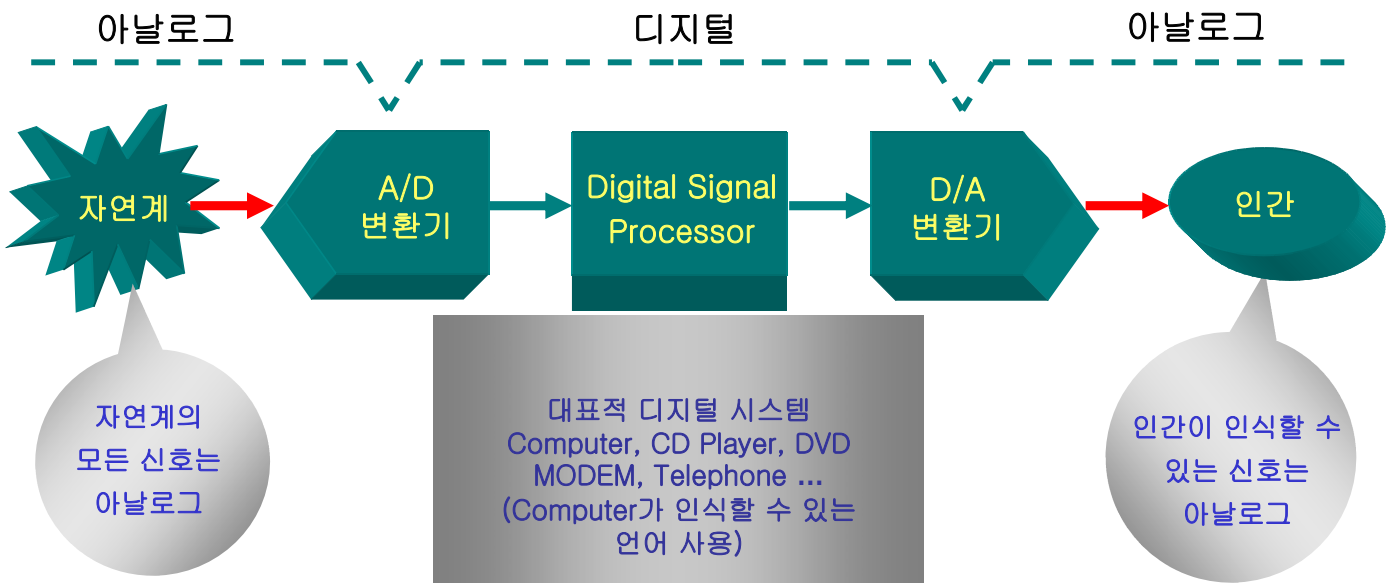
March 7, 2005

Prof. SeongHwan Cho

Outline

- **ADC Necessity**
- **FLASH ADC**
- **Pipeline ADC**
- **Op-amp necessity**
- **Amplifier necessity**

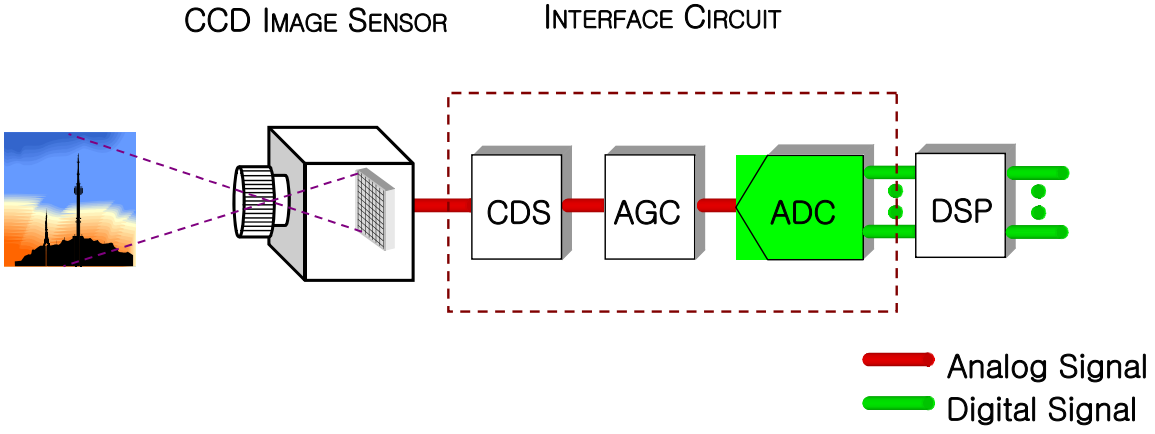
Analog-to-Digital Converter



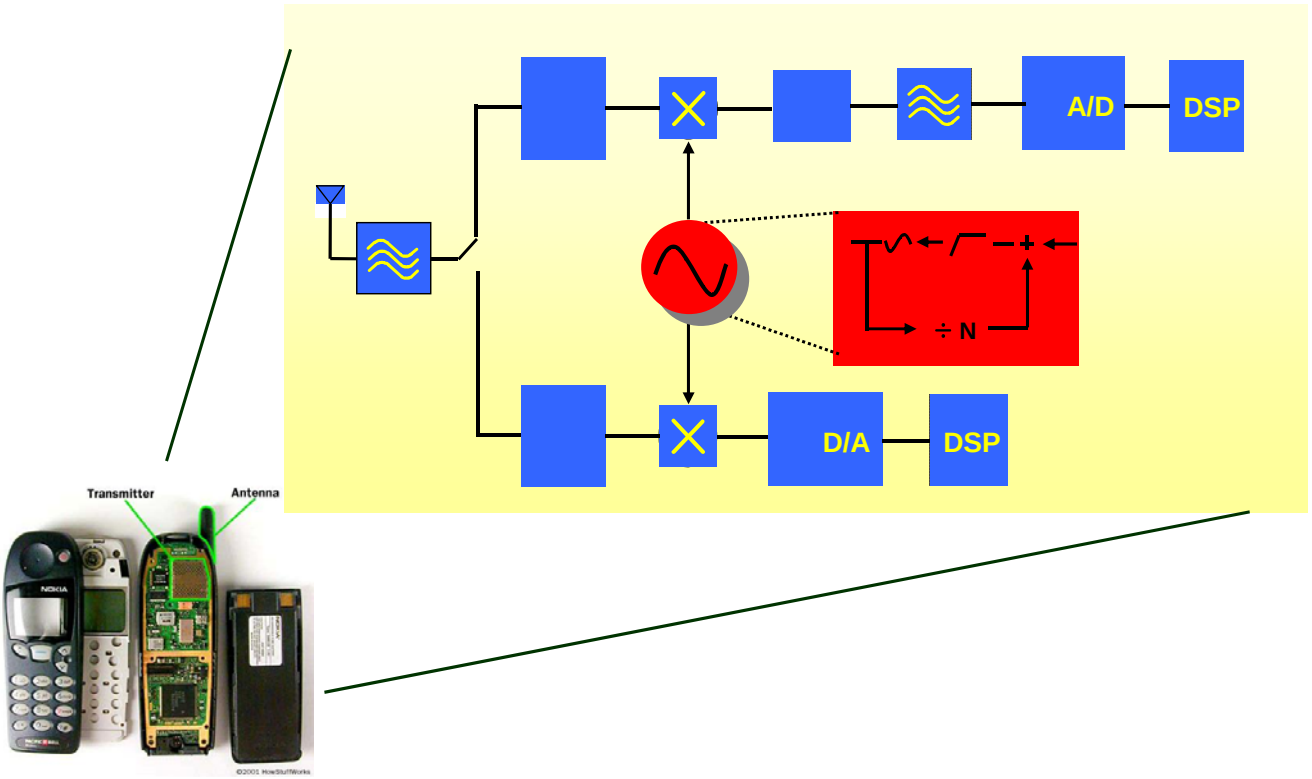
디지털 처리 기술의 장점을 이용하기 위해서는 자연계의 아날로그 입력을 디지털 신호로 변환하는 A/D 변환기와 신호 처리후 디지털 출력을 아날로그 신호로 변환하는 D/A 변환기 등의 interface 회로가 반드시 필요

ADC Application

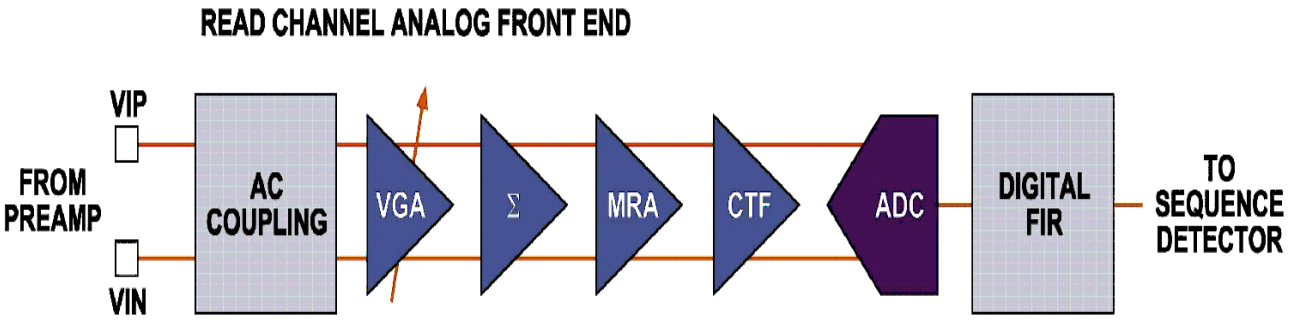
■ **Image Processing (Scanner, Camcorder, Digital Camera, etc)**



Cellular Phone



Hard-disk



ADC Basics

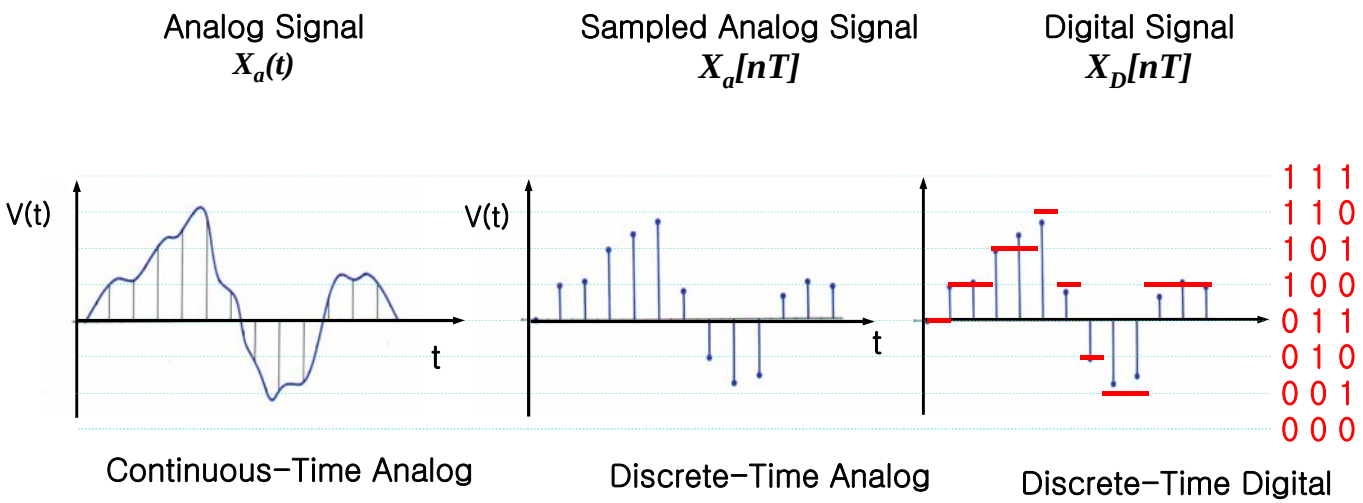
What is the digital value of 5 ?

To answer this question, additional information must be given.

minimum and maximum voltage levels (range/FS)
the number of bits (resolution)

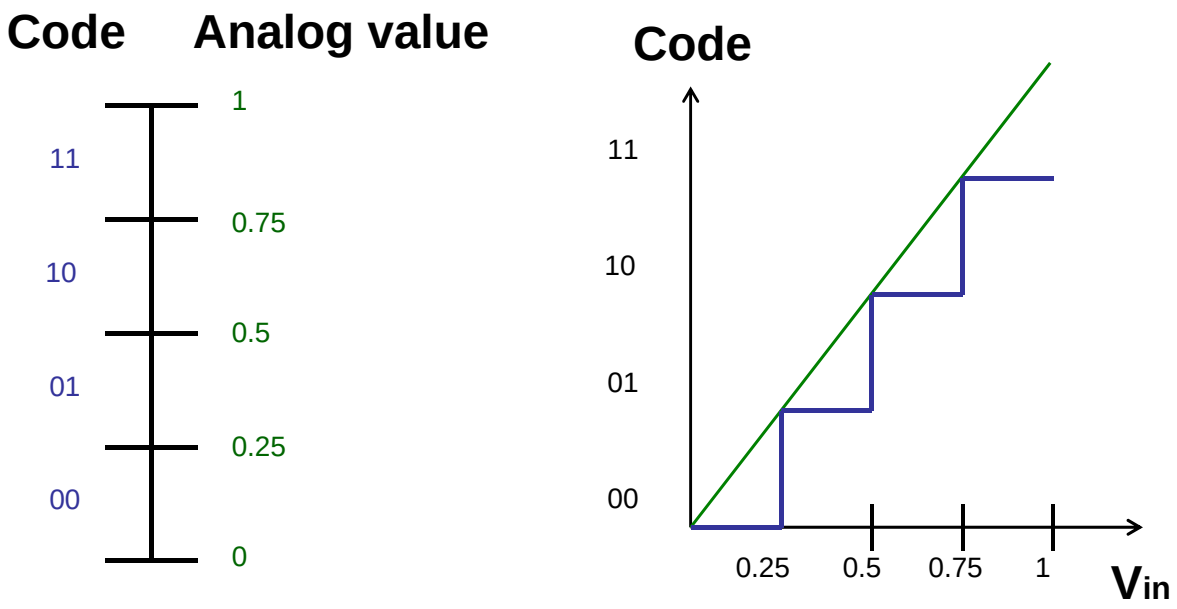
Range	The number of bits	Digital value
0~100[V]	2bits	
0~7[V]	3bits	

Time-Varying Signals



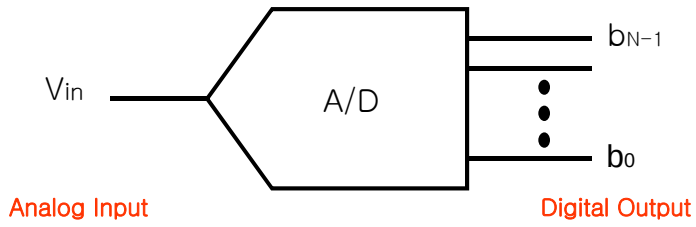
Sample & Hold

Basic Parameters



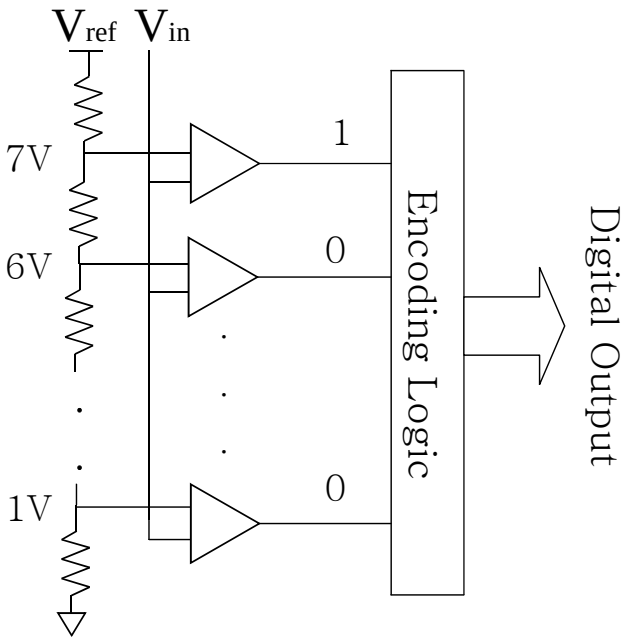
FS (Ref), Resolution, MSB, LSB, Sampling Rate

Data Converter Background



FLASH Architecture

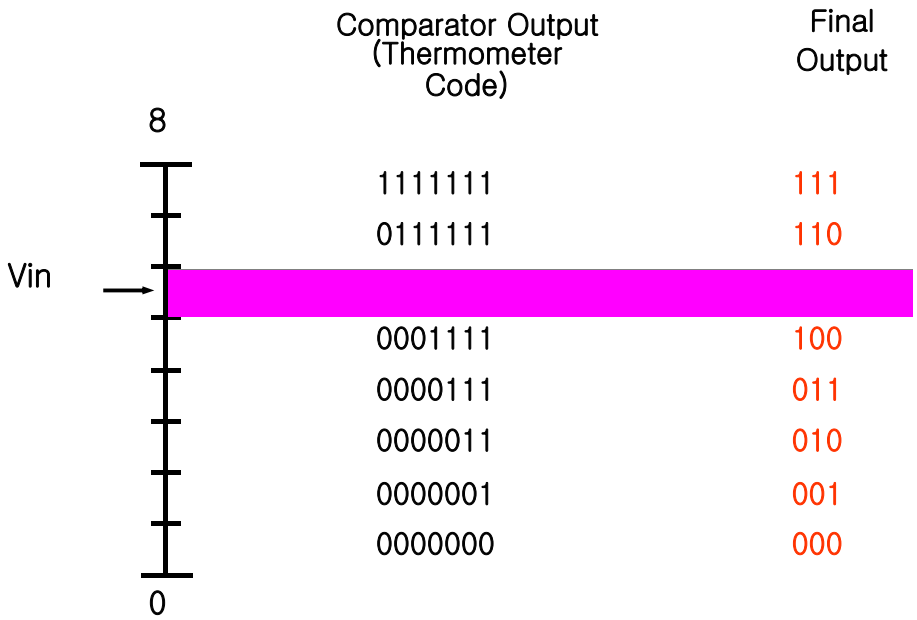
Consider the simplest case : range[0V, 8V] with 3bits



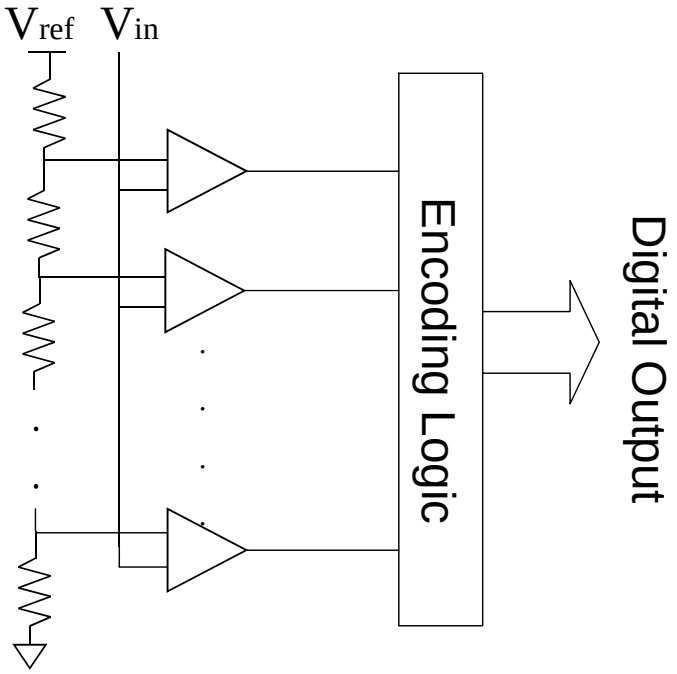
Vin = 6.5V

Digital Output = ?

FLASH Example



FLASH ADCs



Complexity increases exponentially with resolution **!**

Division Method

Consider the simplest case : range[0V, 8V] with 3bits

In this case, reference voltage should be 4V.

$$\begin{array}{r} 1 \\ 4\overline{)\,6.5} \\ \underline{4} \\ 2.5 \end{array}$$

First stage

$$\begin{array}{r} 1 \\ 4\overline{)\,5.0} \\ \underline{4} \\ 1.0 \end{array}$$

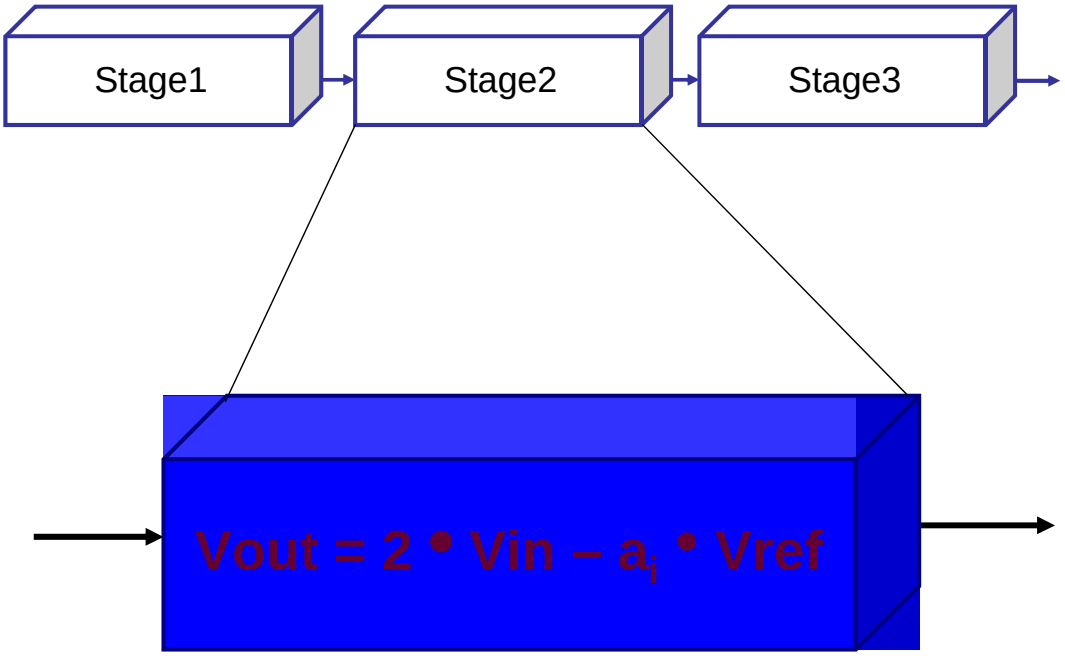
Second stage

$$\begin{array}{r} 0 \\ 4\overline{)\,2.0} \\ \underline{0} \\ 2.0 \end{array}$$

third stage

Therefore 6.5V is converted into the digital value of _____ !

Pipelined ADC Architecture



How to Realize Pipelined ADC

To realize precise pipelined ADCs, we have to realize three operations precisely.

1. Comparator

2. Multiplier by two

3. Subtractor

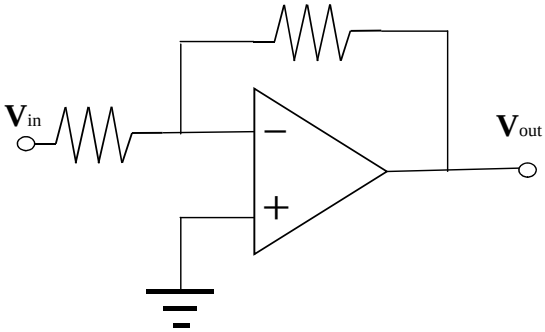
Necessity of Gain Elements

Pipelined ADC requires x2 Circuit.

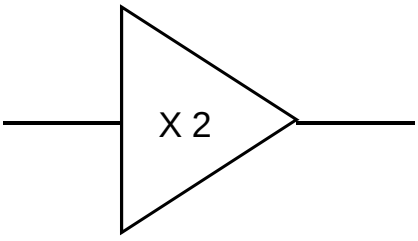
Audio and RF signals must be amplified.

Comparator needs amplifier.

How to design multiply-by-2



Inverting amplifier
with Op-amp



Why not just x2 ?

Either way, we need a gain element .

A/D 변환기 (ADC) 의 응용 분야 및 사양

■ 응용 분야 :

- 개인 휴대용 통신 기기, 고속 디지털 통신망, **HDTV**, 디지털 캠코더, **DVD, LCD** 모니터, 컬러 스캐너 등 제반 시스템 **I.C.** 분야
- 최근 상용 전자 제품들의 성능이 크게 향상됨에 따라 고속도, 고해상도 및 특히 저전력 **A/D** 변환기에 대한 요구가 급속히 증가

■ 응용 분야에 따른 **A/D** 변환기 사양 **(**예**) :**

응 용 분 야	해 상 도 (bits)	속 도 (Sampling Frequency)
Modem	**8 – 10**	**64 KHz**
Digital Audio	**16**	**44.1 KHz**
HDTV, 통신	**10 – 16**	**1 – 100 MHz**
DVD	**8 - 9**	**104 MHz**
LCD	**8**	**205 MHz**

A/D 변환기 (ADC) Applications